

FIG. 1A

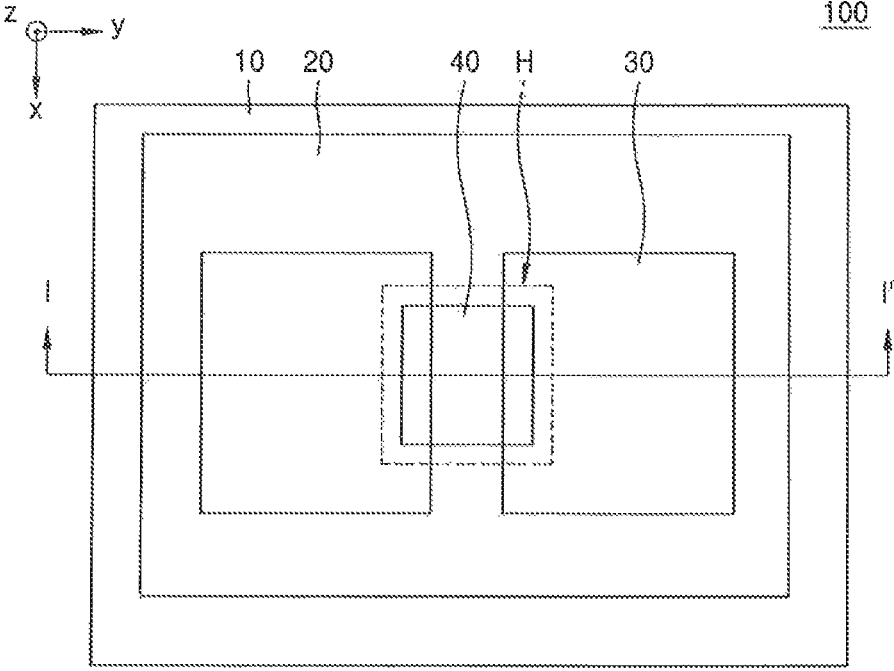


FIG. 1B

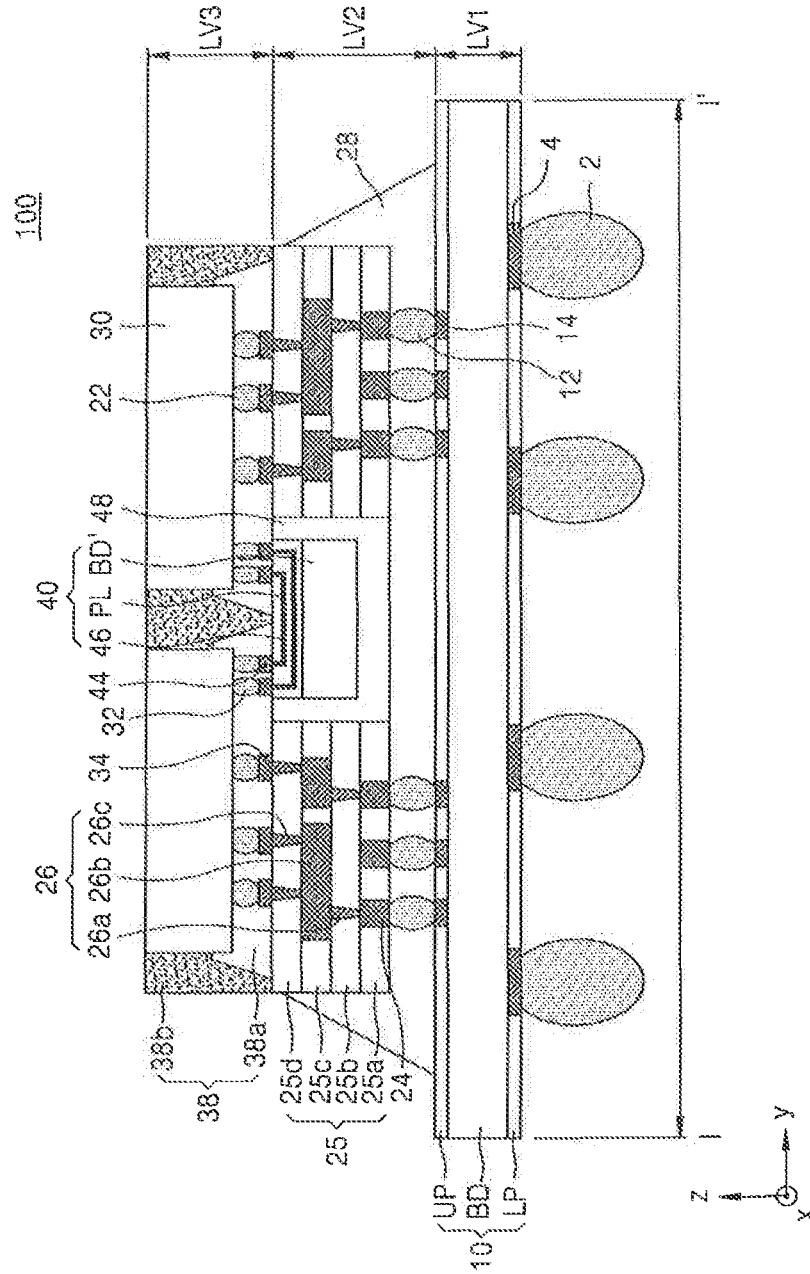


FIG. 2

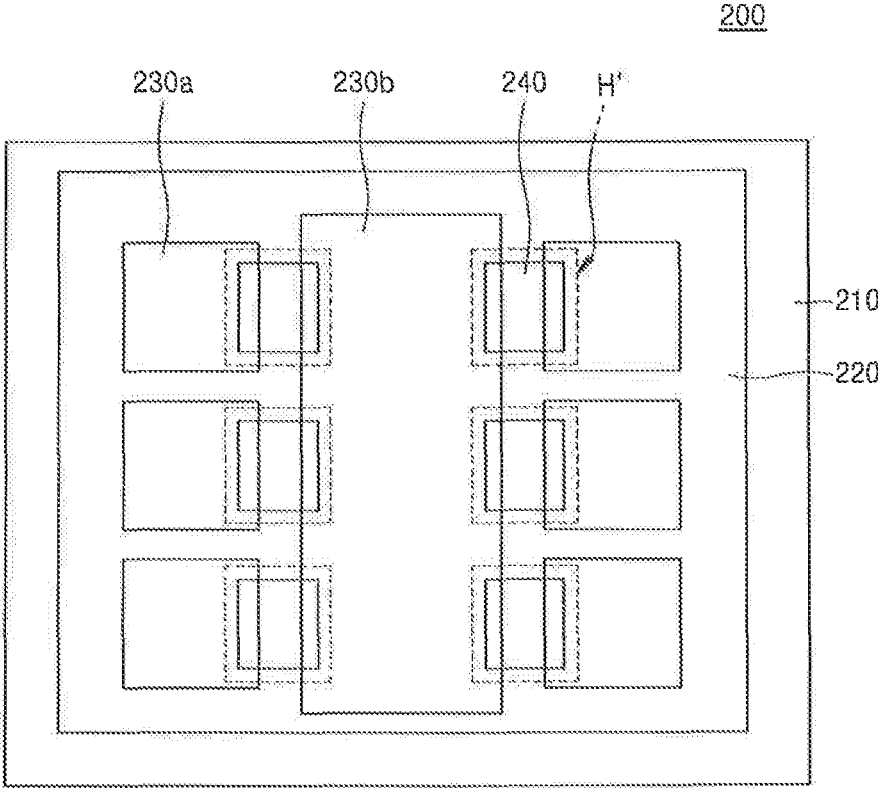


FIG. 3

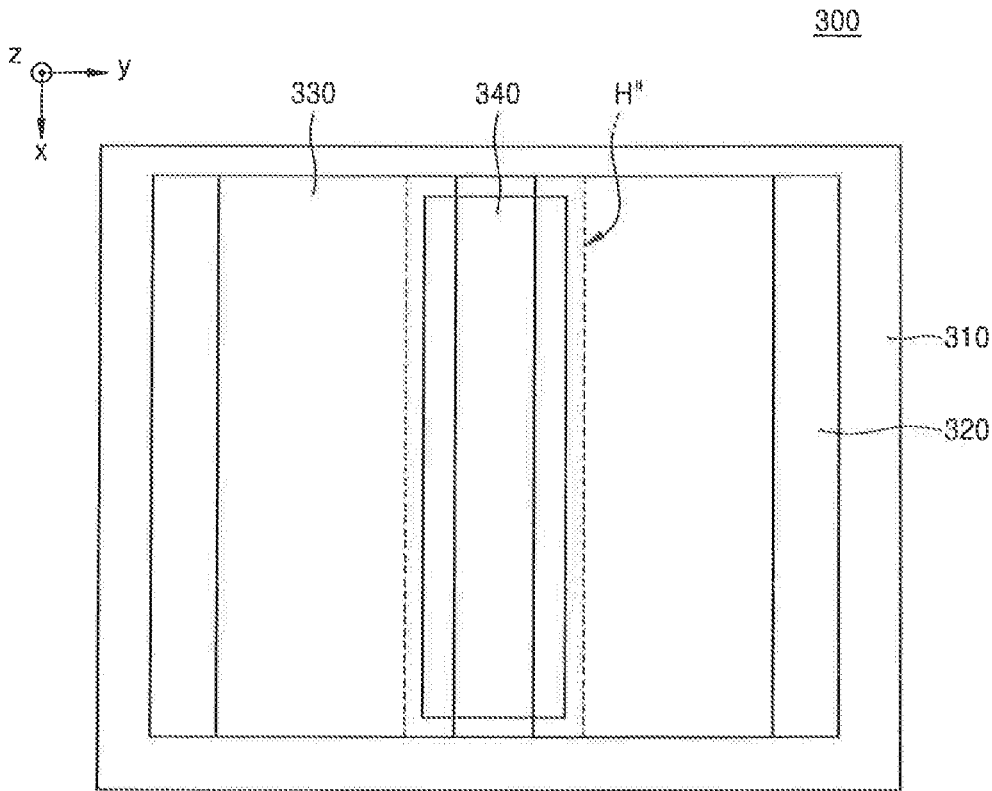


FIG. 4

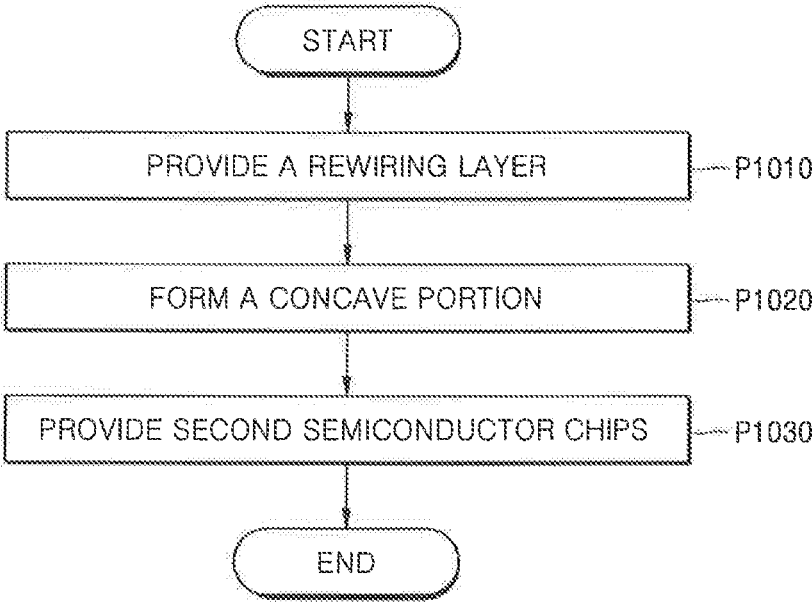


FIG. 5A

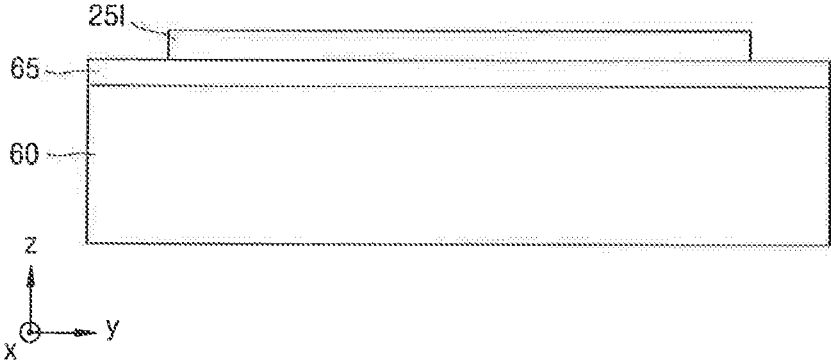


FIG. 5B

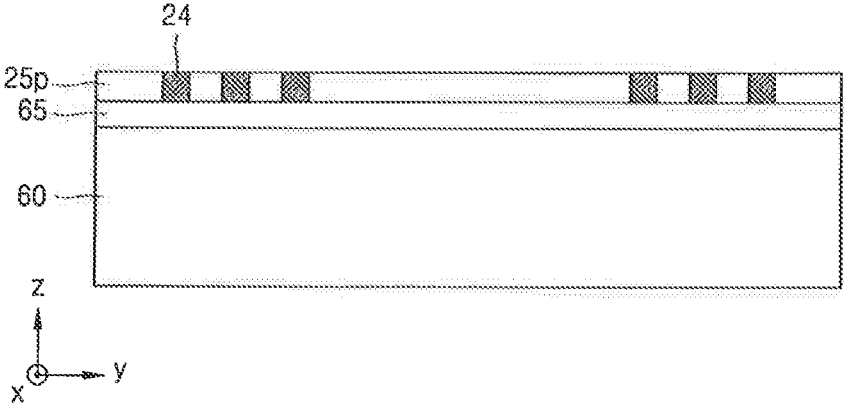


FIG. 5C

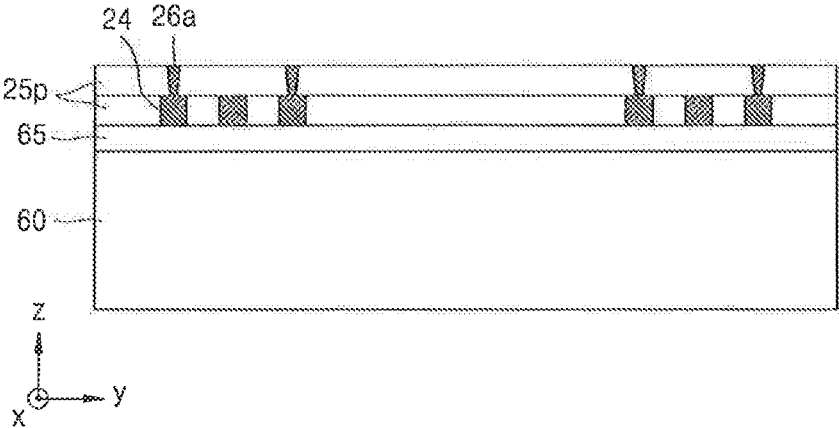


FIG. 5D

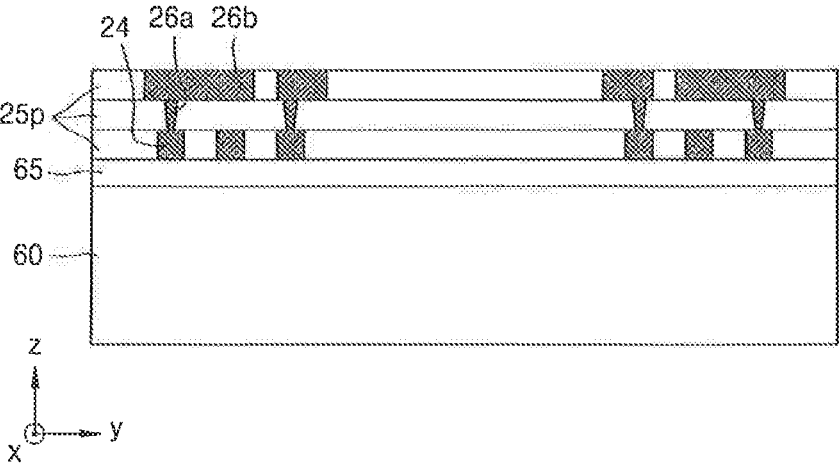


FIG. 5E

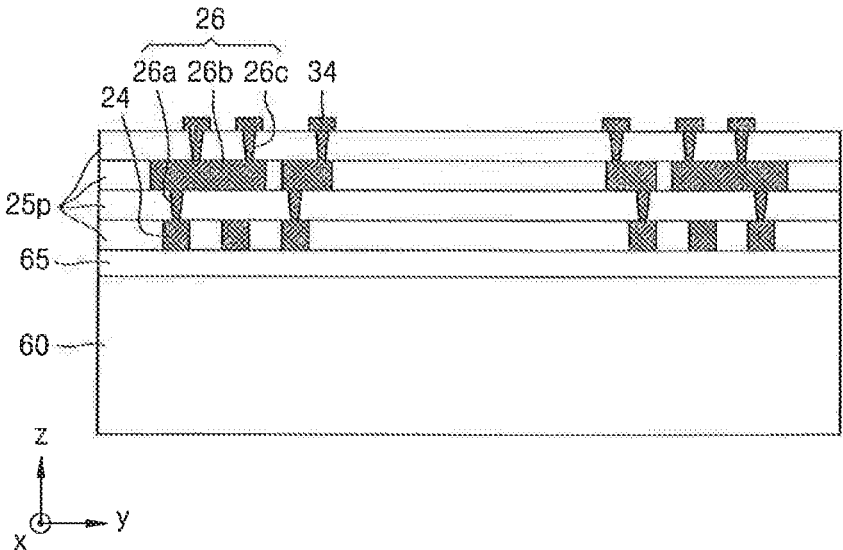


FIG. 5F

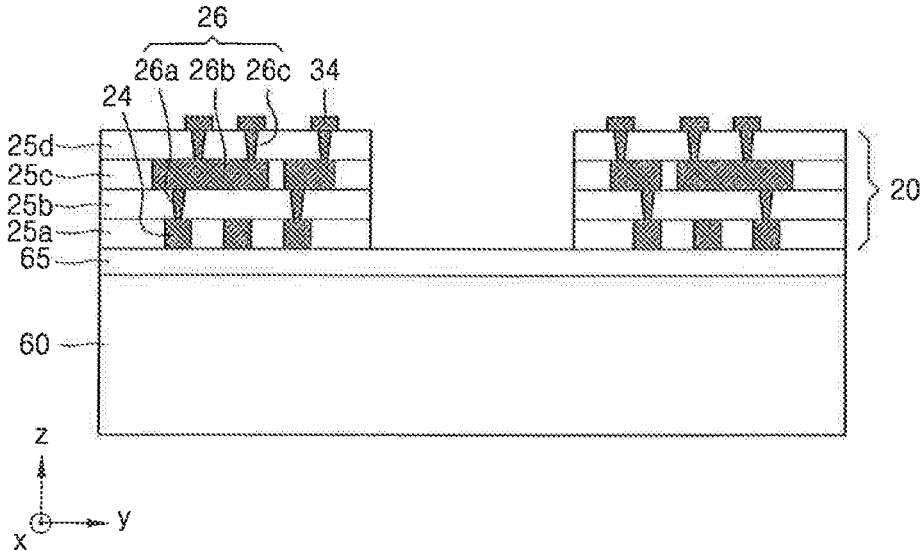


FIG. 5G

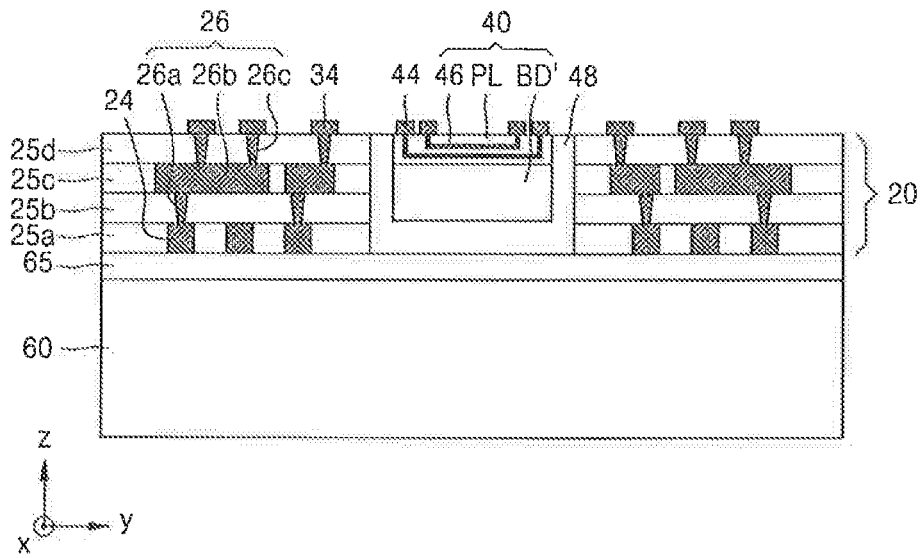


FIG. 5H

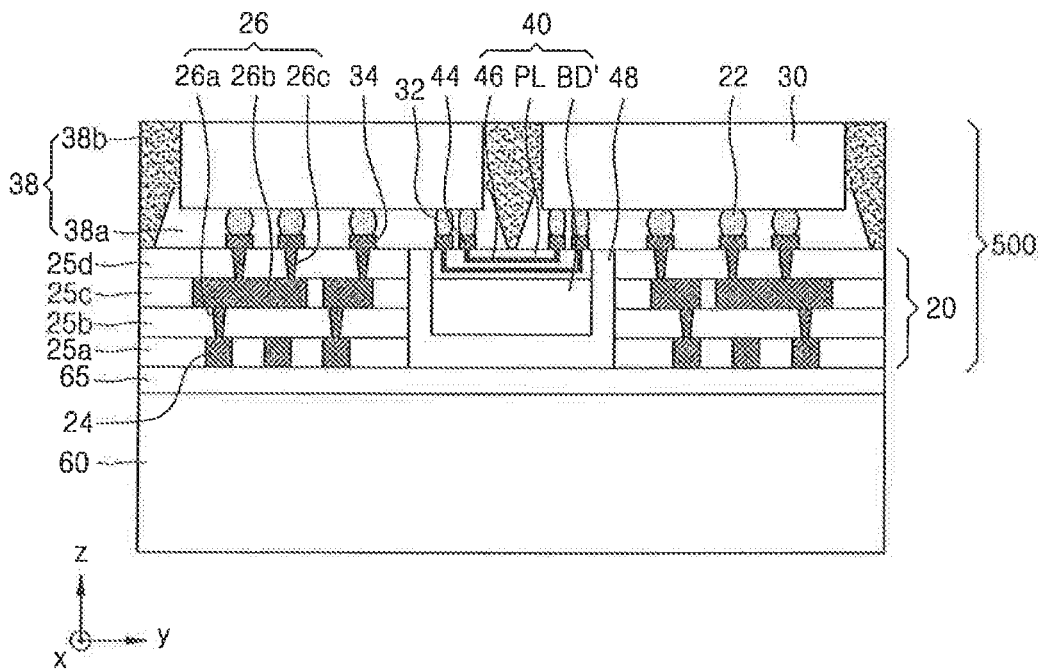


FIG. 6A

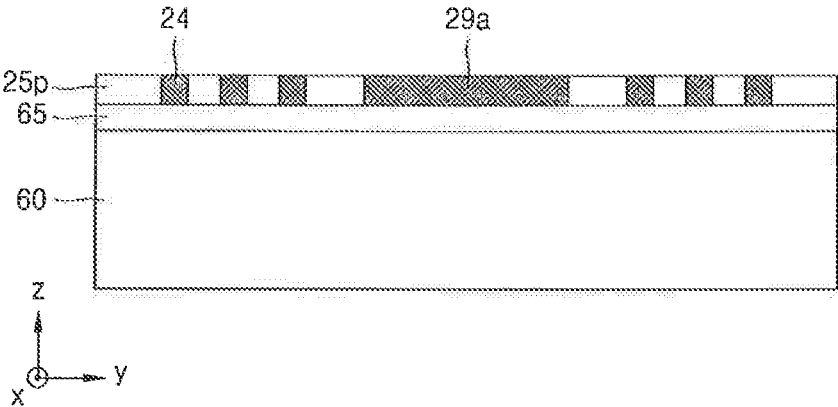


FIG. 6B

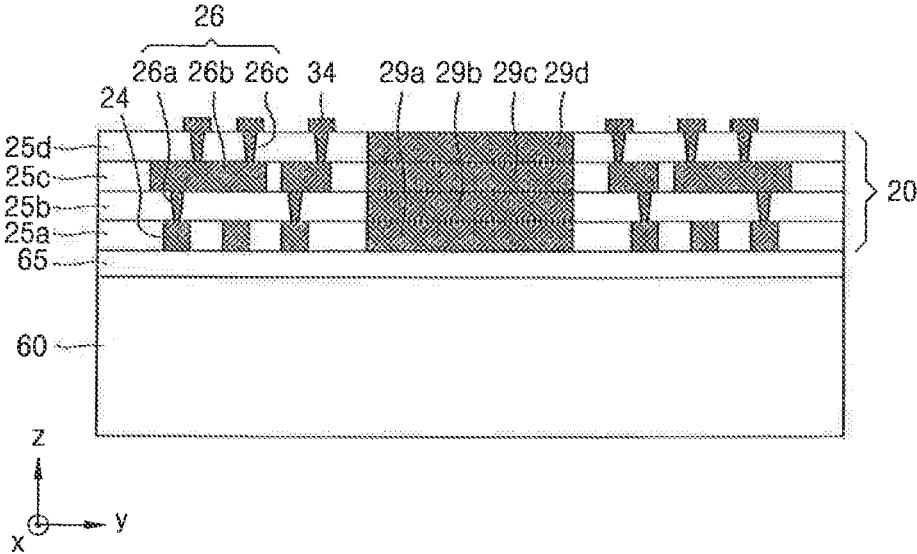


FIG. 6C

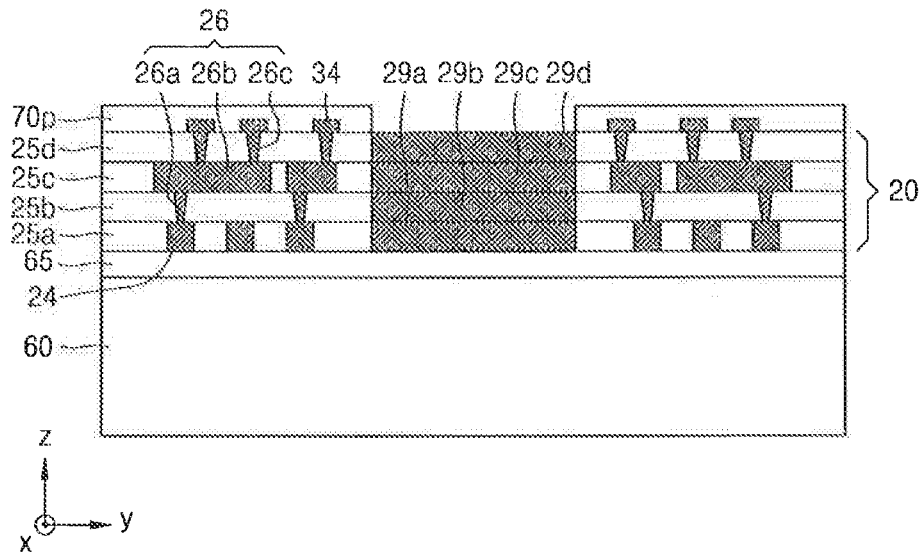
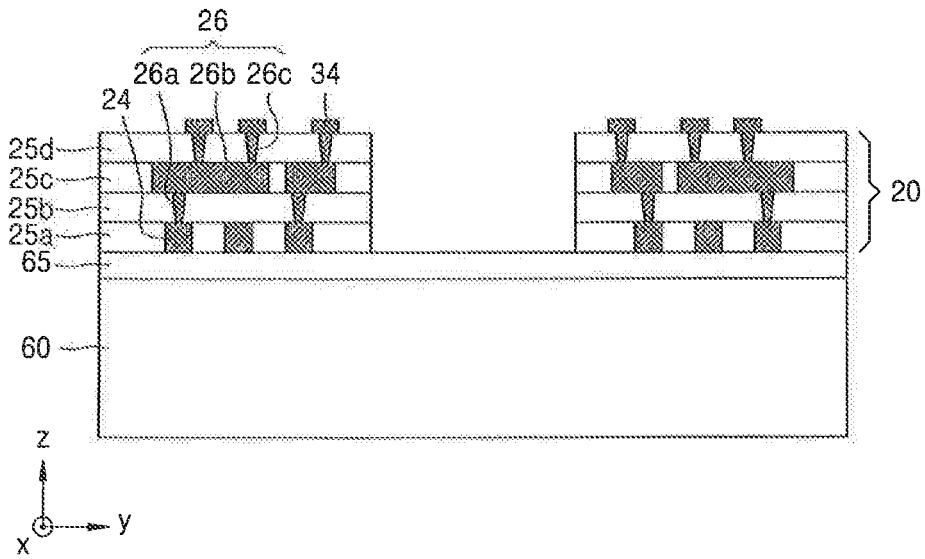


FIG. 6D



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SEMICONDUCTOR PACKAGE INCLUDING A REWIRING LAYER WITH AN EMBEDDED CHIP

CROSS-REFERENCE TO RELATED APPLICATION

This application is a continuation of U.S. application Ser. No. 15/468,294, filed on Mar. 24, 2017, which claims priority under 35 U.S.C. § 119 to Korean Patent Application No. 10-2016-0100126, filed on Aug. 5, 2016 in the Korean Intellectual Property Office, the disclosure of which is incorporated by reference herein in its entirety.

TECHNICAL FIELD

The present inventive concept relates to a semiconductor package, and more particularly, a semiconductor package including a rewiring layer with a semiconductor chip embedded therein.

DISCUSSION OF RELATED ART

A semiconductor package may have a relatively high capacity and a relatively small size. To increase capacity of a semiconductor chip, technology for manufacturing the semiconductor chip including more cells in a relatively limited space is required. However, technology may need an advanced technique such as a precise fine line width. Thus, a method of implementing a relatively high integration using a semiconductor chip or a semiconductor package, for example, a multi-chip stacked package or a stack type semiconductor package in which semiconductor chips are stacked in a 3-dimensional manner may be desirable.

SUMMARY

Exemplary embodiments of the present inventive concept provide a semiconductor package, and more particularly a semiconductor package that may increase a yield of a printed circuit board (PCB), reduce manufacturing expenses, and minimize a warpage of a rewiring layer.

According to an exemplary embodiment of the present inventive concept a semiconductor package is provided. The semiconductor package includes a substrate, a rewiring layer, a plurality of semiconductor chip stack structures, and a second semiconductor chip. The rewiring layer is disposed on an upper surface of the substrate. The rewiring layer includes a concave portion. The semiconductor chip stack structures include a plurality of first semiconductor chips. The semiconductor chips are disposed on the rewiring layer. The semiconductor chips are spaced apart from each other in a horizontal direction. The second semiconductor chip is disposed within the concave portion. The second semiconductor chip is configured to electrically connect the plurality of semiconductor chip stack structures to each other.

According to an exemplary embodiment of the present inventive concept, a semiconductor package is provided. The semiconductor package includes a substrate, a plurality of semiconductor chip stack structures, a first rewiring layer, and a bridge layer. The substrate is formed at a first level. The semiconductor chip stack structures are formed at a third level. The semiconductor chip stack structures are spaced apart from each other in a horizontal direction. The first rewiring layer is formed at a second level. The second level is disposed between the first level and the third level. The first rewiring layer electrically connects the substrate

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and at least one of the semiconductor chip stack structures. The bridge layer is formed at the second level. The bridge layer electrically connects at least one of the semiconductor chip stack structures.

According to an exemplary embodiment of the present inventive concept, a semiconductor package is provided. The semiconductor package includes a substrate, a rewiring layer, a plurality of semiconductor chip stack structures, and a second semiconductor chip. The rewiring layer is disposed on the substrate. The rewiring layer includes a concave portion. The semiconductor chip stack structures are disposed on the rewiring layer. The second semiconductor chip is disposed within the concave portion. The second semiconductor chip is configured to electrically connect the semiconductor chip stack structures to each other.

BRIEF DESCRIPTION OF THE DRAWINGS

Exemplary embodiments of the present inventive concept will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings, in which:

FIG. 1A is a schematic plan view illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept;

FIG. 1B is a cross-sectional view taken along a line I-I' of FIG. 1A illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept;

FIGS. 2 and 3 are plan views illustrating semiconductor packages according to an exemplary embodiment of the present inventive concept;

FIG. 4 is a schematic flowchart illustrating a process of forming a semiconductor package according to an exemplary embodiment of the present inventive concept;

FIGS. 5A to 5H are cross-sectional views of FIG. 1B illustrating a method of manufacturing a semiconductor package according to an exemplary embodiment of the present invention; and

FIGS. 6A to 6D are cross-sectional views illustrating a method of manufacturing a semiconductor package according to an exemplary embodiment of the present inventive concept.

DETAILED DESCRIPTION OF THE EMBODIMENTS

FIG. 1A is a schematic plan view illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept. FIG. 1B is a cross-sectional view taken along a line I-I' of FIG. 1A illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept.

Referring to FIGS. 1A and 1B, the semiconductor package 100 may include a substrate 10. The substrate 10 may be a support substrate. The semiconductor package 100 may also include a rewiring layer 20, a second semiconductor chip 40, and a plurality of semiconductor chip stack structures 30. The rewiring layer 20, the second semiconductor chip 40, and the semiconductor chip stack structures 30 may each be disposed on the substrate 10. The substrate 10 may include a first body layer BD, a lower protection layer LP, and an upper protection layer UP. The substrate 10 may be a printed circuit board (PCB), a ceramic substrate, a glass substrate, or an interpose substrate. The substrate 10 may also be an active wafer. The active wafer may refer to a wafer in which a semiconductor chip is formed, for example, a silicon wafer.

A direction substantially perpendicular to an upper surface of the substrate **10** may be defined as a first direction (e.g., a Z-direction). Two directions substantially parallel to the upper surface of the substrate **10** may be defined as a second direction (e.g., a X-direction) and a third direction (e.g., a Y-direction), respectively. The second direction (e.g., the X-direction) and the third direction (e.g., the Y-direction) may cross each other. For example, the second direction (e.g., the X-direction) and the third direction (e.g., the Y-direction) may cross in a direction substantially perpendicular to each other. The second direction (e.g., the X-direction) and the third direction (e.g., the Y-direction) may each be substantially perpendicular to the first direction (e.g., the Z-direction). A direction indicated as an arrow and a direction opposite thereto in FIGS. **1A** and **1B** will be described herein as the same direction.

In the semiconductor package **100**, the substrate **10** may be a PCB, for example, a molded under-fill (MUF) PCB. However, the substrate **10** is not limited thereto. An MUF process may refer to a process of sealing a boundary part of a semiconductor chip and a space part between the semiconductor chip and a PCB with substantially the same sealing resin through one-shot molding. Alternatively, the MUF process may refer to a process of sealing boundary parts of one or more semiconductor chips with substantially the same sealing resin through one-shot molding. A PCB used in the MUF process may be referred to as the MUF PCB. Wirings may be formed in the substrate **10**. The substrate **10** may be configured to be electrically connected to external connection terminals **2**. The substrate **10** may be electrically connected to the external connection terminals **2** through external connection pads **4**. The external connection terminals **2** may be arranged on a lower surface of the substrate **10**. For example, the external connection terminals **2** may be arranged on a surface opposite to a surface on which the semiconductor chip stack structures **30** are mounted.

The substrate **10** may be disposed on the module substrate or the system board through the external connection terminals **2**. The external connection terminals **2** may include conductive bumps, solder balls, conductive spacers, pin grid arrays (PGAs), or solder bumps. This description may apply to a plurality of first connection terminals **12**, a plurality of second connection terminals **22**, and a plurality of third connection terminals **32** that will be described below.

The first body layer **BD** may include wiring patterns. The wiring patterns may have a multi-layered structure. Alternatively, the wiring patterns may have a single layered structure. The semiconductor package **100** may include internal connection pads **14**. The internal connection pads **14** may be configured to be electrically connected to the external connection terminals **2**. The internal connection pads **14** and the external connection terminals **2** may be electrically connected to each other through the wiring patterns. The semiconductor package may include a lower protection layer **LP** and an upper protection layer **UP**. The lower protection layer **LP** and the upper protection layer **UP** may each protect the first body layer **BD**. The lower protection layer **LP** and the upper protection layer **UP** may each include, for example, a solder resist (**SR**).

When the substrate **10** is a PCB, the first body layer **BD** may be formed by compressing phenol, epoxy glass (or FR-4) resin to a predetermined thickness, forming a thin film, coating both sides of the thin film with a copper foil, and forming a wiring pattern through patterning. The wiring pattern may be a transfer path of an electrical signal. The lower protection layer **LP** and the upper protection layer **UP**

may be formed by electrically connecting wiring patterns formed on upper and lower surfaces through a via contact. The via contact may penetrate into the first body layer **BD**. The lower protection layer **LP** and the upper protection layer **UP** may further be formed by coating an upper surface and a lower surface of the first body layer **BD** with a solder resist layer. For example, substantially the entire upper and lower surfaces of the first body layer **BD** may be coated with the solder resist layer. The terminal connection parts might not be coated with the solder resist layer. Terminal connection parts may refer to parts in which the internal connection pads **14** and the external connection pads **4** are formed.

The external connection pads **4** and the internal connection pads **14** may include copper (Cu), aluminum (Al), nickel (Ni), silver (Ag), gold (Au), platinum (Pt), tin (Sn), lead (Pb), titanium (Ti), chromium (Cr), palladium (Pd), indium (In), zinc (Zn), carbon (C), or a combination/alloy thereof. The semiconductor package **100** may include first connection pads **24**, second connection pads **34**, and third connection pads **44**. Compositions of the first to third connection pads **24**, **34**, and **44** may be substantially the same as compositions of the external connection pads **4** and the internal connection pads **14**.

The PCB may be a single-layered PCB. The single-layered PCB may have a wiring formed on one surface thereof. Alternatively, the PCB may be a double-layered PCB. The double-layered PCB may have wirings formed on both surfaces thereof. An insulator may form at least three copper foil layers and at least three wiring layers. The insulator may be a prepreg. The insulator may form copper wiring layers according to the number of the formed copper foil layers. Thus, a PCB having multiple wiring layers may be formed. However, the substrate **10** of the semiconductor package **100** is not limited to the structure or the material of the PCB described above.

The rewiring layer **20** may be formed on the substrate **10**. The rewiring layer **20** may include a plurality of insulating layers **25a**, **25b**, **25c**, and **25d**. The insulating layers **25a**, **25b**, **25c**, and **25d** may be sequentially provided on the substrate **10**. The rewiring layer **20** may also include a first wiring **26**. The first wiring layer **26** may be formed on the insulating layers **25a**, **25b**, **25c**, and **25d**. Although the rewiring layer **20** may include four insulating layers as illustrated in FIG. **1B**, exemplary embodiments of the inventive concept are not limited thereto. For example, the rewiring layer **20** may include three or less insulating layers or at least five insulating layers. The insulating layers **25a**, **25b**, **25c**, and **25d** may include an insulating material, for example, phenol or epoxy glass (or FR-4) resin, a prepreg, Ajinomoto build-up film (ABF), or polyimide.

The first wiring **26** may include a first via **26a**, a rewiring pattern **26b**, and a second via **26c**. The first via **26a** and the second via **26c** may extend in the first direction (e.g., the Z-direction). The first via **26a** and the second via **26c** may have a stuffed pillar shape or a cylindrical shape. Top critical dimension (CD) of the first via **26a** and the second via **26c** may be greater than bottom CD of the first via **26a** and the second via **26c**, respectively. However, exemplary embodiments of the inventive concept are not limited thereto. The rewiring pattern **26b** may extend in a horizontal direction, for example, the third direction (e.g., the Y-direction). Thus, vias and a rewiring pattern may be used to form a line structure as illustrated in FIG. **1B**; however, exemplary embodiments of the inventive concept are not limited thereto. Regarding a design of the circuit, the line structure may include more or less vias and rewiring patterns.

The first via **26a**, the rewiring pattern **26b**, and the second via **26c** may include copper (Cu), aluminum (Al), nickel (Ni), silver (Ag), gold (Au), platinum (Pt), tin (Sn), lead (Pb), titanium (Ti), chromium (Cr), palladium (Pd), indium (In), zinc (Zn), carbon (C), or a combination/alloy thereof. The semiconductor package **100** may include a second wiring **46**. A composition of the second wiring **46** may be substantially the same as compositions of the first via **26a**, the rewiring pattern **26b**, and the second via **26c**.

The first wiring **26** may be formed through a photolithography process. Each of line and space specifications of the first wiring **26** may be more than about 2 μm . Alternatively, a half pitch of the first wiring **26** may be more than about 2 μm or one pitch thereof may be more than about 4 μm . However, exemplary embodiments of the present inventive concept are not limited thereto.

The first connection pads **24** may be formed on substantially the same level as the insulating layer **25a**. Accordingly, the first connection pads **24** may be formed on a lowest layer of the insulating layers **25a**, **25b**, **25c**, and **25d**. The first connection pads **24** may electrically connect the first wiring **26** and the first connection terminals **12**. Thus, the first connection pads **24** may be configured to be electrically connected to the substrate **10**. The first connection pads **24** may be electrically connected to the substrate **10** through the first connection terminals **12**.

The second connection pads **34** may be formed on the insulating layer **25d**. Accordingly, the second connection pads **34** may be formed on the highest layer of the insulating layers **25a**, **25b**, **25c**, and **25d**. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the second connection pads **34** may be formed at substantially the same plane as the insulating layer **25d**. Accordingly, the second connection pads **34** may be formed on the highest layer of the insulating layers **25a**, **25b**, **25c**, and **25d**.

The second connection pads **34** may electrically connect the first wiring **26** and the second connection terminals **22**. Thus, the substrate **10** may be configured to be electrically connected to the semiconductor chip structures **30** via the first connection terminals **12**, the first connection pads **24**, the first wiring **26**, the second connection pads **34**, and the second connection terminals **22**. Accordingly, sizes of the first connection pads **24** may be greater than sizes of the second connection pads **34**.

The rewiring layer **20** may have a concave portion H. The concave portion H may penetrate into the rewiring layer **20**. The concave portion H may be formed at substantially the same plane as the rewiring layer **20**. Alternatively, a height of the concave portion H in a vertical direction may be substantially the same as a height of the rewiring layer **20** in a vertical direction. The height of the concave portion H in the vertical direction may be substantially the same as a stack height of the insulating layers **25a**, **25b**, **25c**, and **25d**. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the height of the concave portion H in the vertical direction may be smaller than the height of the rewiring layer **20** in the vertical direction. The concave portion H might not extend in some of the insulating layers **25a**, **25b**, **25c**, and **25d**. For example, the concave portion H might not extend in the insulating layer **25a**. The insulating layer **25a** may be the lowest layer of the insulating layers **25a**, **25b**, **25c**, and **25d**. The concave portion H may be formed by etching a plurality of insulating layer providing patterns **25p** illustrated in FIG. **5E**) of the rewiring layer **20**. A hollow generated by etching the insulating layer providing patterns **25p** may become the

concave portion H. Thus, the height of the concave portion H in the vertical direction may be different according to an etching degree of the insulating layer providing patterns **25p**. The rewiring layer **20** may include two stack structures. The two stack structures may be divided by the concave portion H. The second semiconductor chip **40** may be mounted in the concave portion H. Thus, a horizontal cross-sectional area of the concave portion H may be greater than a horizontal cross-sectional area of the second semiconductor chip **40**.

The semiconductor chip stack structures **30** may be arranged on the rewiring layer **20**. The semiconductor chip stack structures **30** may be spaced apart from each other in a horizontal direction. The semiconductor chip stack structures **30** may include a plurality of first semiconductor chips. The first semiconductor chips may be stacked in a direction substantially perpendicular to an upper surface of the substrate **10**.

The first semiconductor chips may be non-volatile memory devices. Thus, the first semiconductor chips may electrically erase and program data. The first semiconductor chips may also maintain the data even if power is blocked. According to an exemplary embodiment of the present inventive concept, a NAND-type flash memory device may be provided as a non-volatile memory device. The NAND-type flash memory device may have a relatively high capacity and a relatively high speed storage capability. The first semiconductor chips may include PRAM, MRAM, ReRAM, FRAM, or NOR flash memory. The first semiconductor chips may be volatile memory devices. Thus, the first semiconductor chips may lose data when power is blocked, such as DRAM or SRAM. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the first semiconductor chips may be logic chips, measuring devices, communication devices, digital signal processors (DSPs), or system-on-chips (SoCs). The semiconductor chip stack structures **30** may include different types of first semiconductor chips.

The second semiconductor chip **40** may be inserted into the concave portion H. Thus, a horizontal cross-sectional area of the second semiconductor chip **40** may be substantially smaller than a horizontal cross-sectional area of the concave portion H. A height of the second semiconductor chip **40** in a vertical direction may be substantially smaller than a height of the concave portion H in the vertical direction. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the height of the second semiconductor chip **40** in the vertical direction may be substantially the same as or greater than a height of the concave portion H in the vertical direction. Although one second semiconductor chip **40** may be inserted into the concave portion H as illustrated in FIGS. **1A** and **1B**, exemplary embodiments of the present inventive concept are not limited thereto. For example, at least two second semiconductor chips may be inserted into the concave portion H.

The second semiconductor chip **40** may include a second body layer **BD'**, a passivation layer **PL**, and the second wiring **46**. The second wiring **46** may be an internal wiring. The second body layer **BD'** may be substantially the same as the first body layer **BD** of the substrate **10**. The second body layer **BD'** may be based on an active wafer. The active wafer may be a wafer other than an interpose substrate. Alternatively, the second body layer **BD'** may include a semiconductor chip. The semiconductor chip may be silicon (Si) based. Alternatively, the second body layer **BD'** may include an active element. The second body layer **BD'** may include

a logic chip, a measuring device, a communication device, a digital signal processor (DSP), or a system on chip (SoC).

The passivation layer PL may protect the second body layer BD' from external physical and chemical damage. The passivation layer PL may protect the second body layer BD' similar to the upper protection layer UP or the lower protection layer LP. The passivation layer PL may include an oxide layer or a nitride layer. Alternatively, the passivation layer PL may include a double layer. The double layer may include the oxide layer and the nitride layer. The passivation layer PL may include an oxide layer or a nitride layer formed through a HDP-CVD (high density plasma chemical vapor deposition) process, for example, a silicon oxide (SiO₂) layer, and/or a silicon nitride (SiN_x) layer. The insulating layer 25d that is the highest layer of the insulating layers 25a, 25b, 25c, and 25d and the passivation layer PL may be formed on substantially the same plane. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the insulating layer 25d that is the highest layer of the insulating layers 25a, 25b, 25c, and 25d and the passivation layer PL may be formed at different planes. The passivation layer PL may coat an upper surface of the second body layer BD'. The passivation layer PL may coat the upper surface of the second body layer BD' except for portions of the second body layer BD' in which the second wiring 46 is formed. The second wiring 46 may penetrate into a portion of the passivation layer PL. The passivation layer PL may be formed by being coated with the silicon oxide layer, the silicon nitride (SiN_x) layer, or the double layer including the silicon oxide layer and the silicon nitride (SiN_x) layer.

The third connection pads 44 may be formed on the passivation layer PL. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the third connection pads 44 may be formed on substantially the same plane as the passivation layer PL. The second connection pads 34 and the third connection pads 44 may be formed on substantially the same plane.

The second semiconductor chip 40 may be configured to be electrically connected to the third connection terminals 32. The third connection terminals 32 may be disposed between the second semiconductor chip 40 and the semiconductor chip stack structures 30. The second semiconductor chip 40 may be electrically connected to the third connection terminals 32 through the third connection pads 44. The second semiconductor chip 40 may be configured as a bridge layer. The bridge layer may electrically connect the semiconductor chip stack structures 30 spaced apart from each other in a horizontal direction to each other.

The second semiconductor chip 40 may include the second wiring 46. The second wiring 46 may be a fine line structure. The second wiring 46 may be configured to be electrically connected to the third connection pads 44. Each of line and space specifications of the second wiring 46 may be less than about 2 μm. A half pitch of the second wiring 46 may be less than about 2 μm. One pitch of the second wiring 46 may be less than about 4 μm. Alternatively, a critical dimension (CD) of the second wiring 46 may be less than about 2 μm. However, exemplary embodiments of the present inventive concept are not limited thereto.

A size of the first connection pads 24 may be greater than a size of the second connection pads 34 and the third connection pads 44. Connection pads for electrical connections with a substrate, in particular, a PCB substrate, may be larger than connection pads for electrical connections between semiconductor chips, in order to increase efficiency of contact and a degree of freedom of wiring. Furthermore,

a size of the second connection pads 34 may be substantially the same as or greater than a size of the third connection pads 44. The third connection pads 44 may be connected to the second wiring 46 having the fine line structure. The fine line structure of the second wiring 46 may be relatively difficult to implement by using general etching technology, such as photolithography. Thus, a size of the second connection pads 34 may be substantially the same as or greater than a size of the third connection pads 44.

A size of the first connection terminals 12 may be greater than a size of the second connection terminals 22 and the third connection terminals 32. A size of the second connection terminals 22 may be substantially the same as or greater than a size of the third connection terminals 32.

Conventional interposer technologies for connecting different semiconductor chips may include a Si-interposer, an organic interposer, a fan-out wafer level package (FO-WLP), or an embedded multi-die interconnect bridge (EMIB). The Si-interposer may have expense increase and yield problem due to a through silicon via (TSV) and barrier/seed (B/S) process. The Si-interposer may also have expense increase and yield problem due to an increase in a chip size. The organic interposer and the FO-WLP may be relatively difficult to implement the fine line structure. The organic interposer and the FO-WLP may be relatively difficult to implement the fine line structure due to a limited process caused by a warpage. The EMIB may embed a SI bridge chip in a PCB having fine and multi-pitch pads. Thus, the EMIB may cause a warpage during a process of mounting a chip having a solder bump of a fine structure on the PCB.

According to an exemplary embodiment of the present inventive concept, internal wirings of a substrate may be minimized. To minimize the internal wirings of the substrate 10, the semiconductor chip stack structures 30 and the substrate 10 may be configured to be electrically connected to each other. The semiconductor chip stack structures 30 and the substrate 10 may be configured to be electrically connected to each other by separately forming the rewiring layer 20 on the substrate 10. Furthermore, a fine line structure that may be relatively difficult to implement in the rewiring layer 20 through general etching may be implemented by mounting a bridge layer. The bridge layer may have a Si-based fine line structure, for example, the second semiconductor chip 40.

The second semiconductor chip 40 may be attached to the rewiring layer 20. The second semiconductor chip 40 may be attached to the rewiring layer 20 by an adhesion member 48. The adhesion member 48 surrounds side surfaces and lower surfaces of the second semiconductor chip 40 as illustrated in FIG. 1B; however, exemplary embodiments of the present inventive concept are not limited thereto. For example, the adhesion member 48 may be in direct contact with the side surfaces or the lower surface of the second semiconductor chip 40. The adhesion member 48 may include a non-conductive film (NCF), an anisotropic conductive film (ACF), an UV film, an instant adhesive, a thermosetting adhesive, a laser curable adhesive, an ultrasound curable adhesive, a non-conductive paste (NCP), or a die attach film (DAF). Upper surfaces of the second semiconductor chip 40, the adhesion member 48, and the insulating layer 25d that is the highest layer of the insulating layers 25a, 25b, 25c, and 25d may form substantially the same plane. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the upper surfaces of the adhesion member 48 and the second semiconductor chip 40 may be lower than the upper

surface of the insulating layer **25d** that is the highest layer of the insulating layers **25a**, **25b**, **25c**, and **25d** in a vertical cross-section.

A chip sealing member **38** may be configured to seal the plurality of semiconductor chip stack structures **30**. The chip sealing member **38** may protect the semiconductor chip stack structures **30** from outside impurities. The chip sealing member **38** may include, for example, an epoxy molding compound (EMC), a silicon-based material, a thermosetting material, a thermoplastic material, or a UV curable material. The thermosetting material may include a phenol type curing agent, an acid anhydride type curing agent, an amine type curing agent, an acrylic polymer additive, or any combination thereof.

The chip sealing member **38** may be formed through a wafer-level molding process. The chip sealing member **38** may be formed at a wafer level. The wafer level may be disposed before a wiring package **500** as illustrated in FIG. **5H**. The chip sealing member **38** may be disassembled as a unit wiring package. The unit wiring package may be disposed on a carrier **60** as illustrated in FIG. **5H**. The chip sealing member **38** may include a chip under-fill **38a** and a chip mold **38b**. The chip under-fill **38a** may be formed by using, for example, a capillary under-fill method. The chip mold **38b** may cover and protect the semiconductor chip stack structures **30**. The chip sealing member **38** may be formed through an MUF process. Accordingly, a material covering exposed parts, such as edges, of the first semiconductor chips and a material filling between the semiconductor chip stack structures **30** and the rewiring layer **20** may be substantially the same.

A package sealing member **28** may seal side surfaces and lower surfaces of the rewiring layer **20**. The package sealing member **28** may seal side surfaces and lower surfaces of the chip sealing member **38**. A composition of the package sealing member **28** may be substantially the same as a composition of the chip sealing member **38**. Thus, the rewiring layer **20**, the semiconductor chip stack structures **30**, and the second semiconductor chip **40** may be protected from outside impurities.

The semiconductor package **100** may include the substrate **10**. The substrate **10** may be formed at a first level LV1. The semiconductor package **100** may also include the semiconductor chip stack structures **30**. The semiconductor chip stack structures **30** may be spaced apart from each other in a horizontal direction. The semiconductor chip stack structures **30** may be disposed at a third level LV3. The semiconductor chip stack structures **30** may be spaced in a vertical direction to the first level LV1. The semiconductor package **100** may also include the rewiring layer **20** and a bridge layer, for example, the second semiconductor chip **40**. The rewiring layer **20** and the bridge layer may each be formed at a second level LV2. The second level LV2 may be disposed between the first level LV1 and the third level LV3. The rewiring layer **20** may electrically connect the substrate **10** and at least one of the semiconductor chip stack structures **30**. The bridge layer, for example, the second semiconductor chip **40**, may electrically connect at least one of the semiconductor chip stack structures **30** to each other. The semiconductor package **100** may include the rewiring layer **20** formed at a different level from the substrate **10**. For example, the substrate may be formed at the first level LV1 and the rewiring layer **20** may be formed at the second level LV2.

FIG. **2** is a plan view illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept.

A semiconductor package **200** may include a substrate **210**. The substrate **210** may be formed at a first level. The semiconductor package **200** may also include a plurality of semiconductor chip stack structures **230a** and **230b**. The semiconductor chip stack structures **230a** and **230b** may be spaced apart from each other in a horizontal direction. The semiconductor chip stack structures **230a** and **230b** may be formed at a third level. The semiconductor package **200** may include a rewiring layer **220** and a bridge layer, for example, a second semiconductor chip **240**. The rewiring layer **220** and the bridge layer may be formed at a second level. The second level may be disposed between the first level and the third level. The rewiring layer **220** may be configured to electrically connect the substrate **210** and at least one of the semiconductor chip stack structures **230a** and **230b**.

The bridge layer, for example, the second semiconductor chip **240**, may be inserted into the rewiring layer **220**. The rewiring layer **220** may include a plurality of concave portions H'. Each of the concave portions H' may include a plurality of bridge layers, for example, the second semiconductor chips **240**. The bridge layers, for example, the second semiconductor chips **240**, may electrically connect at least one of the semiconductor chip stack structures **230a** and **230b**. The concave portions H' may be formed at the second level. The second semiconductor chips **240** may be inserted into the concave portions H', respectively. The second semiconductor chips **240** may be arranged at the second level. Although sizes or shapes of the concave portions H' may be substantially the same to each other as illustrated in FIG. **2**, exemplary embodiments of the present inventive concept are not limited thereto. Sizes or shapes of the concave portions H' may be modified according to sizes of the second semiconductor chips **240** respectively inserted into the concave portions H'. Sizes or shapes of the concave portions H' may also be modified according to locational relationships between the semiconductor chip stack structures **230a** and **230b**.

The semiconductor chip stack structures **230a** and **230b** may include first semiconductor chip stack structures **230a** and a second semiconductor chip stack structure **230b**. Each of the first semiconductor chip stack structures **230a** may be configured to electrically connect the second semiconductor chip stack structure **230b** to each other through the bridge layer. According to an exemplary embodiment of the present inventive concept, for example, the first semiconductor chip stack structures **230a** may be a stack of the above-described memory chips. The second semiconductor chip stack structure **230b** may include an active element, a logic chip, or an application specific integrated circuit (ASIC).

FIG. **3** is a plan view illustrating a semiconductor package according to an exemplary embodiment of the present inventive concept.

A semiconductor package **300** may include a substrate **310**. The substrate **310** may be formed at a first level. The semiconductor package **300** may also include a plurality of semiconductor chip stack structures **330**. The semiconductor chip stack structures **330** may be spaced apart from each other in a horizontal direction. The semiconductor chip stack structures **330** may be formed at a third level. The semiconductor package **300** may also include a rewiring layer **320** and a bridge layer, for example, a second semiconductor chip **340**. The rewiring layer **320** and the bridge layer, for example, the second semiconductor chip **340**, may be formed at a second level. The second level may be disposed between the first level and the third level.

A concave portion H'' may be formed at substantially the same level as the rewiring layer **320**. A length of the concave

portion H" and a length of the rewiring layer 320 may be substantially the same in a second direction (e.g., an X-direction). The second direction (e.g., the X-direction) may be a direction substantially horizontal to an upper surface of the substrate 310. When a height of the concave portion H" and a height of the rewiring layer 320 in a vertical direction are substantially the same, the rewiring layer 320 may be divided into two regions. The rewiring layer 320 may be divided into two regions by the concave portion H". The semiconductor package 300 may include a plurality of rewiring layers 320. The rewiring layers 320 may be spaced in a horizontal direction. Empty spaces disposed between the plurality of rewiring layers 320, for example, hollows, may refer to the concave portions H". The second semiconductor chips 340 may be arranged between adjacent rewiring layers 320.

Referring to FIGS. 2 and 3, the rewiring layers 220 and 320, locations and shapes of the concave portions H' and H", and arrangements of the second semiconductor chips 240 and 340 may vary, for example, in accordance with product properties and design considerations.

FIG. 4 is a schematic flowchart illustrating a process of forming a semiconductor package according to an exemplary embodiment of the present inventive concept. FIGS. 5A to 5I are cross-sectional views of FIG. 1B illustrating a method of manufacturing a semiconductor package according to an exemplary embodiment of the present inventive concept.

Referring to FIGS. 4 and 5A, in a process P1010 of providing a rewiring layer, a carrier fixing layer 65 and the carrier 60 may be provided. The carrier 60 may be a rigid body, for example, a quartz substrate, a glass substrate, a semiconductor substrate, a ceramic substrate, or a metal substrate. The carrier 60 may include a relatively rigid material. The carrier 60 may have a mechanical rigidity. The carrier 60 may support a rewiring layer that is being formed. Thus, the carrier 60 may facilitate a process of forming the rewiring layer. The carrier 60 may perform a wafer level process. The wafer level process may minimize an occurrence of a warpage. A thickness of the carrier 60 may range from about 100 μm to about 1,000 μm . However, the thickness of the carrier 60 is not limited thereto. For example, the thickness of the carrier 60 may be smaller than about 100 μm or greater than about 1,000 μm . Performing a manufacturing process at a wafer level may refer to directly mounting a semiconductor chip on a wafer in a wafer state. Performing a manufacturing process at a wafer level may also refer to performing a trimming process or a grinding process. Performing a manufacturing process at a wafer level may also refer to performing a manufacturing process after cutting the wafer into individual base chips or individual chips and rearranging individual base chips or individual chips on a support substrate of a wafer size.

The carrier fixing layer 65 may be formed on the carrier 60. The carrier fixing layer 65 may affix an insulating layer providing layer 25I to the carrier 60. Thus, the carrier fixing layer 65 may include an adhesive material. The carrier fixing layer 65 may be an adhesion layer. The adhesion layer may affix the insulating layer providing layer 25I to the carrier 60. The adhesion layer may include glue. The carrier fixing layer 65 may include a polymer. For example, the carrier fixing layer 65 may include siloxane. The carrier fixing layer 65 may include siloxane including a phenol group. Alternatively, the carrier fixing layer 65 may be cross-linked through epoxy. For example, the carrier fixing layer 65 may include a polymer in which epoxy is used as a cross-linker in the siloxane including the phenol group.

The carrier fixing layer 65 may be formed by using a spin on deposition (SOD) method. Thus, the carrier fixing layer 65 may be substantially uniformly coated on the carrier 60; however, exemplary embodiments of the present inventive concept are not limited thereto.

A release layer may be provided on the carrier fixing layer 65. The release layer may separate the carrier 60 from the rewiring layer 20 as illustrated in FIG. 5D. The release layer may separate the carrier 60 from the rewiring layer 20 after a manufacturing process including the carrier 60. However, during the manufacturing process including the carrier 60, the release layer may also affix to each of the carrier 60 and the rewiring layer 20 as illustrated in FIG. 5D. The release layer may include a polymer. The release layer may include siloxane.

The insulating layer providing layer 25I may be provided on the carrier fixing layer 65. Chemical vapor deposition (CVD), for example, may be used to substantially uniformly provide the insulating layer providing layer 25I on the carrier fixing layer 65. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the insulating layer providing layer 25I may be provided by using SOL), physical vapor deposition (PVD), or atomic layer deposition (ALD). The insulating layer providing layer 25I may have substantially the same composition as the composition of the insulating layers 25a, 25b, 25c, and 25d described with reference to FIGS. 1A and 1B.

Referring to FIGS. 4 and 5B, in the process P1010, an insulating layer providing pattern 25P may be provided. A photo resist may be coated on the insulating layer providing layer 25I. The insulating layer providing layer 25I may be patterned. The insulating layer providing layer 25I may be patterned through exposure and development. Thus a photo resist pattern may be formed. A region in which the first connection pads 24 are to be formed may be defined by the photo resist pattern. The insulating layer providing layer 25I may then be etched. The insulating layer providing layer 25I may be etched until an upper surface of the carrier fixing layer 65 is exposed. The insulating layer providing layer 25I may be etched using the photo resist pattern as an etching mask. Thus, the insulating layer providing pattern 25P may be formed.

A conductive material layer may then be provided on the insulating layer providing pattern 25P. The conductive material layer may substantially conformably fill hollows formed in the insulating layer providing pattern 25P. Chemical mechanical polishing (CMP) may be performed by using an upper surface of the insulating layer providing pattern 25P as an etching stop layer. Thus, the first connection pads 24 may be formed. Accordingly, the first connection pads 24 and the insulating layer providing pattern 25P may have substantially the same height. The upper surface of the insulating layer providing pattern 25P may be partially etched during a CMP process.

Referring to FIGS. 4 and 5C, in the process P1010, the insulating layer providing pattern 25P and the first via 26a may be provided substantially the same as described with reference to FIG. 5B. After an insulating layer providing layer is provided on the insulating layer providing layer 25P at substantially the same level as the first connection pads 24, a photo resist pattern may be formed on the insulating layer providing pattern 25P. The photo resist pattern may define the first via 26a in the insulating layer providing layer. The insulating layer providing layer may then be etched by using the photo resist pattern as an etching mask. The insulating layer providing layer may be etched until an upper surface of the first connection pads 24 is exposed. The first

via **26a** may be formed in a first direction (e.g., a Z-direction). The first via **26a** and the insulating layer providing pattern **25p** may be provided by performing a CMP process as described with reference to FIG. **5B**.

Referring to FIGS. **4** and **5D**, in the process **P1010**, as described with reference to FIG. **5B** or **5C**, the insulating layer providing pattern **25p** and the rewiring pattern **26b** may be provided. The rewiring pattern **26b** may be formed in a third direction (e.g., a Y-direction); however, exemplary embodiments of the present inventive concept are not limited thereto. For example, the rewiring pattern **26b** may be formed in a second direction (e.g., an X-direction).

Referring to FIGS. **4** and **5E**, in the process **P1010**, as described with reference to FIG. **5B**, the insulating layer providing pattern **25p**, the first wiring **26**, and the second connection pads **34** may be provided. Adjoining layers that may combine the insulating layer providing patterns **25p** with each other may be provided. The adjoining layers may be provided between the insulating layer providing patterns **25p**. The adjoining layers may include an NCF, an ACF, an UV film, an instant adhesive, a thermosetting adhesive, a laser curable adhesive, an ultrasound curable adhesive, an NCP, or a DAF.

A sacrificial layer may be formed on the insulating layer providing patterns **25p**. The sacrificial layer may have an etching selectivity with respect to the insulating layer providing patterns **25p**. After the sacrificial layer is formed, the second connection pads **34** may be provided as described with reference to FIG. **5B**. The sacrificial layer may then be removed. The sacrificial layers may be removed by using a wet etching method.

When an insulating layer providing layer other than the sacrificial layer is provided to form the second connection pads **34**, the second connection pads **34** may be formed at substantially the same level as the insulating layer providing pattern **25p** of the highest layer in a vertical cross-section. The insulating layer providing pattern **25p** of the highest layer may have a thickness smaller than a thickness of the other insulating layer providing patterns **25p**. The insulating layer providing pattern **25p** of the highest layer may include the second connection pads **34**. The second connection pads **34** may be connected to the semiconductor chip stack structures **30** as illustrated in FIG. **5F**. Sizes of the second connection pads **34** may be smaller than sizes of the first connection pads **24**. The second connection pads **34** may have a height substantially the same as a height of the insulating layer providing pattern **25p** of the highest layer.

Forming of the first wiring **26** as described with reference to FIGS. **5B** to **5E** is an exemplary embodiment of the present inventive concept; however, exemplary embodiments of the present inventive concept are not limited thereto. The forming of the first wiring **26** may be modified, for example, according to a design of a semiconductor package.

Referring to FIGS. **4** and **5F**, in a process **P1020**, the concave portion **H** may be formed. The concave portion **H** may be formed similar to the photolithography method described with reference to FIG. **5A**. However, before a photo resist is formed, a hard mask layer may be formed. The hard mask layer may include an amorphous carbon layer or a polysilicon layer. An anti-reflective coating may be formed on the hard mask layer. A photo resist pattern may be formed by patterning the photo resist. The photo resist may be patterned through exposure and development. Thereafter, a hard mask pattern may be formed by etching the hard mask layer. The hard mask layer may be etched by using the photo resist pattern as an etching mask. After the

photo resist pattern is removed, the hard mask pattern may be formed on the insulating layer providing pattern **25p** of the highest layer. The hard mask pattern may be formed on the insulating layer providing pattern **25a** excluding a part in which the concave portion **H** is formed. The concave portion **H** may be formed by using the hard mask pattern as the etching mask. The insulating layer providing patterns **25p** may then be etched by using the hard mask pattern as the etching mask. However, the exemplary embodiments of the present inventive concept are not limited thereto. The insulating layer providing patterns **25p** may be etched by using the hard mask pattern as the etching mask without the hard mask layer. Accordingly, the insulating layer providing patterns **25p** may become the insulating layers **25a**, **25b**, **25c**, and **25d**.

Referring to FIGS. **4** and **5G**, in a process **P1030**, the second semiconductor chip **40** may be provided in the concave portion **H**. When the second semiconductor chip **40** is provided, a method of providing an amount of the adhesion member **48** to the concave portion **H** and compressing the second semiconductor chip **40** to the adhesion member **48** may be performed. A process of providing the second semiconductor chip **40** may be performed at a wafer level, for example, through a chip on wafer (COW) process. With respect to an array of a plurality of rewiring layers formed on the carrier **60**, the second semiconductor chip **40** may be inserted into the concave portion **H** before each of the rewiring layers is individualized. The second semiconductor chip **40** may be inserted at the wafer level mounted on the carrier **60**. Thus a processing efficiency may be increased and a warpage that may be applied to the rewiring layer **20** or the second semiconductor chip **40** may be minimized. However, exemplary embodiments of the present inventive concept are not limited thereto. The second semiconductor chip **40** may be provided after an individualization process.

Referring to FIGS. **4** and **5H**, the semiconductor chip stack structures **30** may be provided. The second connection terminals **22** may be configured to electrically connect the semiconductor chip stack structures **30** and the rewiring layer **20**. The third connection terminals **32** may be configured to electrically connect the semiconductor chip stack structures **30** and the second semiconductor chip **40**. The semiconductor chip stack structures **30** may also be provided at the wafer level. Thus a processing efficiency may be increased and a warpage may be minimized. However, exemplary embodiments of the present inventive concept are not limited thereto. The semiconductor chip stack structures **30** may be provided after an individualization process.

The chip sealing member **38** may then be provided. The chip sealing member **38** may protect the semiconductor chip stack structures **30**. The chip sealing member **38** may include the chip under-fill **38a** and the chip mold **38b**. The chip under-fill **38a** may be provided by using a capillary under-fill method. The chip mold **38b** may be provided to cover and protect upper surfaces and side surfaces of the semiconductor chip stack structures **30**. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the chip sealing member **38** may be formed through an MUF process. A structure including the rewiring layer **20**, the semiconductor chip stack structures **30**, the chip sealing member **38**, the adhesion member **48**, and the second semiconductor chip **40** may be referred to as the wiring package **500**.

Referring to FIG. **1B**, the semiconductor package **100** may be provided by mounting the wiring package **500** as illustrated in FIG. **5H** on the substrate **10**.

The unit wiring package **500** may be produced by performing an individualization process of dicing the wiring package **500** illustrated in FIG. **5H** into unit structures. The unit wiring package **500** may then be mounted on the substrate **10**. The unit wiring package **500** may be configured to be electrically connected to the substrate **10**. The unit wiring package **500** may be electrically connected to the substrate **10** via the first connection terminal **12** as illustrated in FIG. **1B** and the internal connection pads **14**. The package sealing member **28** may protect the wiring package **500** from external damage factors. The package sealing member **28** may be provided through an under-fill process, for example, an MUF process.

FIGS. **6A** to **6D** are cross-sectional views illustrating a method of manufacturing a semiconductor package according to an exemplary embodiment of the present inventive concept.

Referring to FIG. **6A**, a part in which a concave portion is to be formed may be etched during an etching process. The etching process may include a photo resist pattern. A conductive material layer may be provided on an insulating layer providing layer. The concave portion **H** as illustrated in FIG. **1B** may be formed on the insulating layer providing layer. The conductive material layer may substantially conformably fill hollows formed in the insulating layer providing pattern **25p**. Thereafter, CMP may be performed by using an upper surface of the insulating layer **25a** as an etching stop layer. Thus, the first connection pads **24** and a sacrificial pattern **29a** may be formed.

Referring to FIG. **6B**, similarly as described with reference to FIG. **6A**, when the insulating layer providing layers are etched to form the first rewiring **26** and the second connection pads **34**, a part in which a concave portion is to be formed may be etched. Accordingly, hollows in which sacrificial patterns **29b**, **29c** and **29d** are to be respectively formed in the insulating layer providing layers may be defined. Thus, the sacrificial patterns **29b**, **29c** and **29d** may be formed when the first rewiring **26** and the second connection pads **34** are formed.

Referring to FIG. **6C**, a mask layer pattern **70p** may be formed on the insulating layer **25d** of the highest layer. The mask layer pattern **70p** may prevent the second connection pads **34** exposed during a process of removing a sacrificial pattern from being damaged due to, for example, a wet etching liquid. Thus, the mask layer pattern **70p** may include a material having an etching selectivity with respect to the sacrificial patterns **29b**, **29c**, and **29d**. The mask layer pattern **70p** may be substantially conformably formed on the insulating layer **25d** of the highest layer and the second connection pads **34**. Thus the mask layer pattern **70p** formed on the second connection pads **34** may include an unevenness.

Referring to FIG. **61**), the sacrificial patterns **29b**, **29c** and **29d** may be removed, for example, through wet etching. However, exemplary embodiments of the present inventive concept are not limited thereto. For example, the sacrificial patterns **29b**, **29c**, and **29d** may be removed through dry etching. The mask layer pattern **70p** may be removed after the sacrificial patterns **29b**, **29c**, and **29d** are removed.

The semiconductor packages **100**, **200**, and **300** may be provided through substantially the same process as described with reference to FIGS. **5G** and **5H**.

While exemplary embodiments of the present inventive concept have been particularly shown and described with reference to embodiments thereof, it will be understood that various changes in form and details may be made therein without departing from the spirit and scope of the present inventive concept.

What is claimed is:

1. A semiconductor package, comprising:

a substrate;

a first rewiring layer disposed on an upper surface of the substrate and having a concave portion, the first rewiring layer comprising:

a plurality of first connection pads formed at a bottom surface of the first rewiring layer;

a plurality of first vias and a plurality of second vias extending in a vertical direction;

a plurality of first wiring patterns extending in a horizontal direction, and each of the plurality of first wiring patterns electrically connecting each first via to corresponding second via, the plurality of first wiring patterns having a first minimum pitch; and

a plurality of second connection pads;

a bridge layer formed in the concave portion of the first rewiring layer, the bridge layer including a second semiconductor chip, the second semiconductor chip including a plurality of second wiring patterns having a second minimum pitch, and the second pitch being smaller than the first pitch; and

a plurality of semiconductor chip structures spaced apart from each other in the horizontal direction, and each of the plurality of semiconductor chip structures being overlapped with at least a portion of the first rewiring layer and at least a portion of the bridge layer respectively,

wherein the second semiconductor chip is configured to electrically connect at least two semiconductor chips of the plurality of semiconductor chip structures, and the concave portion is formed through a photolithography process while forming the first rewiring layer.

2. The semiconductor package of claim **1**, further including:

a plurality of second connection terminals formed on the first rewiring layer and electrically connecting the first rewiring layer to the plurality of semiconductor chip structures, a minimum pitch between the second connection terminals being a third pitch; and

a plurality of third connection terminals formed on the second semiconductor chip and electrically connecting the second semiconductor chip to the plurality of semiconductor chip structures, a minimum pitch between the third connection terminals being a fourth pitch,

wherein the fourth pitch is smaller than the third pitch.

3. The semiconductor package of claim **2**, wherein the concave portion is formed while the first and second vias are formed by the photolithography process.

4. The semiconductor package of claim **3**, wherein each size of the plurality of second connection pads is larger than that of the plurality of first connection pads.

5. The semiconductor package of claim **4**, wherein the first vias and the second vias extend in the vertical direction, and penetrate a first insulating layer and a second insulating layer respectively.

6. The semiconductor package of claim **5**, wherein the first and second insulating layers include at least one of phenol, epoxy glass resin, prepreg, Ajinomoto build-up film (ABF), and polyimide.

7. The semiconductor package of claim **5**, wherein the first and second vias include at least one of copper, aluminum, nickel, silver, gold, platinum, tin, lead, titanium, chromium, palladium, indium, zinc, and carbon.

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8. The semiconductor package of claim 1, wherein a minimum line width of the first wiring patterns is greater than a minimum line width of the second wiring patterns.

9. The semiconductor package of claim 8, wherein a composition of the first wiring patterns may be substantially the same as a composition of the second wiring patterns.

10. The semiconductor package of claim 9, wherein the first wiring patterns are formed through a photolithography process.

11. The semiconductor package of claim 2, further including a plurality of first connection terminals electrically connecting the first connection pads and the substrate.

12. The semiconductor package of claim 11, further including a mold filling a space between the bottom surface of the first rewiring layer and the substrate, and at least partially surrounding each of the plurality of first connection terminals.

13. The semiconductor package of claim 1, wherein a height of the concave portion is substantially the same with a height of the first rewiring layer in the vertical direction.

14. The semiconductor package of claim 1, wherein the bridge layer further includes an adhesion member which is in direct contact with side surfaces and a lower surface of the second semiconductor chip.

15. The semiconductor package of claim 14, wherein the adhesion member is in direct contact with the substrate.

16. The semiconductor package of claim 14, wherein the adhesion member is in direct contact with a mold formed between the bridge layer and the substrate.

17. The semiconductor package of claim 16, wherein an upper surface of the adhesion member is coplanar with an upper surface of the second semiconductor chip.

18. The semiconductor package of claim 1, wherein an upper surface of the second semiconductor chip is coplanar with an upper surface of the first rewiring layer.

19. A semiconductor package, comprising:
a substrate;
a first rewiring layer disposed on an upper surface of the substrate, and having a concave portion;
a bridge layer formed in the concave portion of the first rewiring layer, the bridge layer including a second

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semiconductor chip, the second semiconductor chip including a plurality of second wiring patterns;

a first semiconductor chip and a third semiconductor chip disposed on the first rewiring layer and the bridge layer and being spaced apart from each other in a horizontal direction, and each of the first semiconductor chip and the third semiconductor chip being overlapped with at least a portion of the first rewiring layer and at least a portion of the bridge layer respectively;

a plurality of second connection terminals formed on the first rewiring layer and electrically connecting the first rewiring layer to the first semiconductor chip and the third semiconductor chip, a minimum pitch between the second connection terminals being a first pitch; and

a plurality of third connection terminals formed on the second semiconductor chip and electrically connecting the first semiconductor chip and the third semiconductor chip to the second semiconductor chip respectively, a minimum pitch between the third connection terminals being a second pitch, and the second pitch being smaller than the first pitch,

wherein the second wiring pattern electrically connect the first semiconductor chip and the third semiconductor chip, and the concave portion is formed through a photolithography process while forming the first rewiring layer.

20. The semiconductor package of claim 19, wherein the first rewiring layer comprising:

a plurality of first connection pads formed at bottom surface of the first rewiring layer;

a plurality of first vias and a plurality of second vias extending in a vertical direction;

a plurality of first wiring patterns extending in the horizontal direction, and each of the plurality of first wiring patterns electrically connecting each first via to corresponding second via, the plurality of first wiring patterns having a first minimum pitch; and

a plurality of second connection pads, wherein the second wiring patterns have a second minimum pitch, and the second minimum pitch is smaller than the first minimum pitch.

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